GUIDE BOOK No. 6

Excursions in Vicinity of Toronto and to Muskoka and Madoc

Excursions B 2, B 5, B 6, B 8, and B 10

GEOLOGORUM CONVENTUS XII 1913 CANADA MENTE ET MALLEO

ISSUED BY THE ONTARIO BUREAU OF MINES
TORONTO, CANADA

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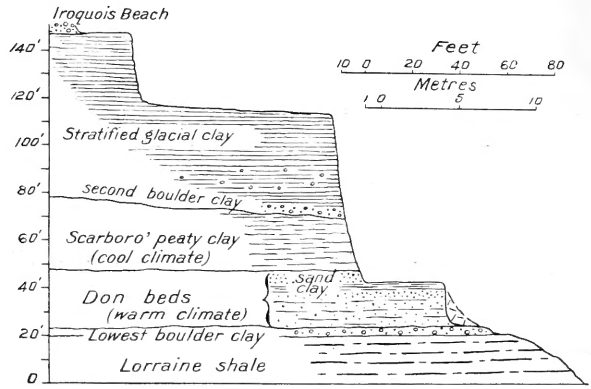
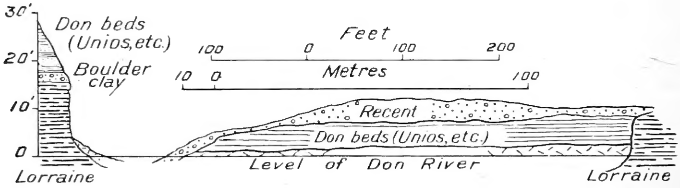


Section at Don Valley Brickyard, Toronto



Section at Bend of Don River

GUIDE BOOK No. 6

Excursions in Vicinity of Toronto and to Muskoka and Madoc.

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EXCURSION B 2.

TORONTO AND VICINITY.

BY

A. P. COLEMAN.

CONTENTS.

INTRODUCTION AND GEOLOGICAL SUMMARY.

Toronto began about 100 years ago as a village at the mouth of the small river Don, where a sand bar, now called Toronto island, enclosed an excellent harbor. It has since expanded six miles west to the Humber river, four or five miles to the east and as much to the north. Its geographical centre is not far from the Meteorological Observatory, on Bloor street West, which is in lat. 43° 40′ 0″.8 and long. 79° 23′ 54″. Toronto is situated on the north shore of lake Ontario about forty miles from its western end.

In discussing the geology of the region it will be advisable to include the suburbs of the city as far east as Highland creek, 13 miles from the Don, and as far north as York Mills, 6 miles from Toronto bay.

Physiographically the region may be divided into two parts, a terrace formed by ancient lake Iroquois, sloping gently upwards from lake Ontario to a height of 176 to 200 feet, and a somewhat higher upland formed of rolling hills of glacial origin, reaching at its highest points 380 feet above the lake, which is 246 feet above the sea.

The comparatively level surfaces of the terrace and the morainic region beyond are broken by the deep valleys of the Don and Humber rivers and their tributaries, which have been cut almost to base level for a mile or two from the shore and ramify as steep walled ravines for several miles inland.

The lake shore is greatly varied, including the flat sand and gravel spit which projects westwards from the Don and then bends northward to enclose Toronto bay, as well as the cliffs of Scarboro heights to the east, which rise 355 feet above the water and form the highest point on the whole shore of lake Ontario. This line of cliffs, extending for nine and a half miles, has been carved by wave action from an ancient promontory and has provided the materials which have been transported ten miles west by the easterly storms to build up Toronto island.

The vicinity of Toronto includes only small outcrops of solid rock, Lorraine shale of Ordovician age; but has a varied and interesting series of Pleistocene deposits unequalled in complexity and importance by any other North American locality. Its thick series of interglacial beds,

the Toronto Formation, gives evidence of an interglacial time far longer than the post-glacial period and with a warmer climate than that of the present.

The geological succession may be arranged as follows:

Recent—River and lake Deposits.

Pleistocene:
- Iroquois Beach Materials.
- Glacial complex (four beds of till with interstratified clay and sand).
- Toronto Interglacial Formation (Scarboro beds, Don beds).
- Earliest Boulder clay.

Palæozoic—Lorraine shale.

These will be described in succession from below upwards.

THE LORRAINE SHALE.

The bed rock of Lorraine shale (Ordovician or Lower Silurian) is generally buried under the drift deposits of the Pleistocene and comes to the surface at comparatively few points and in a quite inconspicuous way. Along the western lake front on Humber bay there are low outcrops rising not more than two or three feet above the water at Exhibition park and west of the Humber river. The shale rises higher along the sides of the river valleys, forming cliffs that reach 30 or 40 feet within the first three or four miles up the Humber, and 10 to 16 feet at the "Bend of the Don," about two miles from the mouth of the river.

All of these natural outcrops are greatly weathered, as might be expected in so easily attacked a rock as shale, and only the harder limey or sandy layers resist the action of rain and frost.

Artificial exposures in connection with the brickyards give the best opportunities to study the unweathered rock, the one most easily reached being at the Don Valley brickyard, where a great open pit from which shale is being quarried shows 60 feet of the formation. There are thin seams of impure limestone at frequent intervals in the shale and these have to be selected out before it is crushed for brickmaking. The weathered surfaces of the discarded limestones provide the best fossils in the Don region. The

brickyard may be reached by taking a Church street car to Glen road, walking north to Binscarth road and then east to the edge of the Don valley, where a path leads down to the shale pit.

There are numerous exposures of the shale along the Humber extending from near lake Ontario to Lambton Mills, two and a half miles up. The best outcrop for a study is just south of the bridge over the Humber at Lambton, where the river flows rapidly over the harder beds, many slabs of which are exposed along its shores. Here, in addition to the limestone layers, there are well ripplemarked sheets of shaly sandstone. The surfaces of the slabs display not only fossils, but a variety of markings supposed to be due to physical causes.

About two miles further up the valley on the west side there is a large shale pit from which materials are got for the manufacture of paving brick. This also affords a good collecting ground. The Lambton outcrops may be reached by taking a Dundas street car to the end of its route and then a Lambton suburban car to Lambton Mills.

The fossils found on the Humber differ somewhat from those at the Don brickyard, as determined by Prof. Parks, the western shale belonging to a somewhat higher horizon owing to a gentle southwesterly dip of the beds. Many of the fossils, however, are common to the two localities, and they are not separated in the list prepared by Prof. Parks. The most striking fossil is *Isotelus maximus* (sometimes called *Asaphus platycephalus*), which is occasionally ten inches in length. The fauna of the Don beds contains some species typical of the Eden of Ohio, while the Humber beds more closely resemble the Lorraine of New York.

List of fossils at Toronto.

Hydrozoa:—
Diplograptus pristis, Hisinger.

Echinoderms:—
Glyptocrinus decadactylus, Hall.
Heterocrinus juvenis, Hall.
Iocrinus subcrassus, M. and W.
Palasterina rugosa, Bill.

Vermes:—
Nereidavus varians, Grinnell.

Brachiopods:—

Leptæna rhomboidalis, Wilckens.
Rafinesquina alternata, Emmons.
Plectambonites sericeus, Sowerby.
Schizocrania filosa, Hall.
Zygospira modesta, Conrad.
Catazyga erratica, Hall.
Dalmanella testudinaria, Dalman.
Lingula sp.
Trematis millepunctata, Hall.
Schizambon cf. *lockei,* W. and S.

Gastropods:—

Crytolites ornatus, Conrad.
Lophospira cf. *perangulata,* Hall.
Protowarthia cancellata, Hall.
Archinacella, sp.

Pelecypoda:—

Byssonychia grandis, Ulrich.
Byssonychia radiata, Hall.
Byssonychia imbricata, Ulrich.
Byssonychia alveolata, Ulrich.
Whiteavesia pholadiformis, Ulrich.
Modiolopsis concentrica, Hall and W.
Modiolopsis modiolaris, Conrad.
Cymatonota recta, Ulr.
Cymatonota, pholadis, Ulr.
Orthodesma parallelum, Hall.
Orthodesma parvum, Ulr.
Lydrodesma poststriatum, Emmons.
Whitella hindi, Bill.
Whitella ventricosa, Ulr.
Cleidophorus neglectus, Hall.
Psiloconcha inornata, Ulr.
Modiolodon obtusus, Ulr
Pterinea demissa, Hall.
Ctenodonta cf. *carinata,* Ulr.

Cephalopoda:—

Orthoceras crebriseptum, Hall.
Endoceras proteiforme, Hall.

Pteropods:—

Conularia formosa, Miller and Dyer.
Tentaculites starlingensis, Meek.

Bryozoa:—

Heterotrypa frondosa, D'Orbigny.
Heterotrypa inflecta, Ulr.
Monotrypa undulata hemispherica, James.
Amplexopora discoidea, Nicholson.
Bythopora delicatula, Nich.
Leptotrypa irregularis, Ulr.
Arthropora schafferi, Ulr.
Peronopora vera, Ulr.
Spatiopora cf. *maculosa*, Ulr.
Atactopora maculata, Ulr.
Dekáyella ulrichi, Nich.
Bythopora arctipora, Nich.
Aspidopora, sp.
Paleschara beani, James.
Chiloporella, sp.
Callopora subplana, Ulr.
Callopora dalei, M-E and H.
Bythopora gracilis, Nich.
Hemiphragma whitfieldi, James.

Trilobites:—

Isotelus maximus, Locke.
Calymene callicephala, Green.
Trinucleus concentricus, Eaton.

PLEISTOCENE BEDS.

The surface of the shale beneath the city had a high relief before the first Pleistocene ice sheet moved down upon it. A wide valley had been carved 200 feet below the general level by a great river which flowed south from the present Georgian bay region, the Laurentian river of Dr. Spencer. Probably a thick layer of preglacial weathered material once covered the surface, as the region is supposed to have been dry land since Palæozoic times, but this was completely swept away, perhaps by the advancing ice, leaving no record between the Ordovician and the end of the Pliocene.

Immediately upon the ancient marine shale one finds a sheet of boulder clay formed by land ice; and succeeding it in some places there are four other till sheets, each separated from the one below by interglacial beds of stratified

gravel, sand and clay, piled up at Scarboro' to a thickness of nearly 400 feet.

The earliest and most important interglacial series includes 185 feet of delta deposits; but the later ones are seldom more than 30 or 40 feet in thickness, and may represent relatively short recessions of the ice. The retreat of each ice sheet in the series was doubtless followed up by a great glacial lake in which stratified deposits were formed. That of the latest (Wisconsin) ice sheet was accompanied by the waters of lake Iroquois, which lasted for thousands of years and left behind the terrace and gravel bars and shore cliffs which are such marked physiographic features at Toronto.

The earliest sheet of till consists of tough blue clay, evidently made largely from the local shale, and containing many angular slabs of its harder layers picked up close by. With them occur some well rounded polished and striated boulders of blue Trenton limestone, smaller boulders of black Utica shale, and many large or small boulders of granite, gneiss, greenstone or schist from the Archæan. No smoothed or striated surface has been found beneath the lowest boulder clay, which seems to pass down into the disturbed Lorraine shale; but the direction of the ice motion is indicated by the boulders of Utica and Trenton rocks, which are found in place in eastern Ontario.

The lowest boulder clay is usually not more than three or four feet thick, and in a few places it is wanting, having been swept away by interglacial rivers. Its best exposure is in a shore cliff near the west end of King street in Parkdale, where it rises four or five feet above the lake and is capped for 800 feet by a well-laid boulder pavement. Above the pavement there are 25 or 30 feet of less solid till formed by the next ice advance, with no interglacial beds intervening.

The flat upper surfaces of the stones in the boulder pavement are usually well and uniformly striated, the direction ranging from 290° to 315° with an average of 300°. The striæ run 30° north of west instead of south of west, as might have been expected. The glacial lobe which had followed the depression of lake Ontario from the east began to spread out towards its west end. A similar boulder pavement occurs in a shore cliff near Port Credit ten miles to the west.

Such boulder pavements imply a long interval between the two ice sheets in which the weather or running water or more probably wave action could remove the clay and allow the boulders to accumulate on the surface. The second ice sheet must have come on gently at first until the boulders were firmly sunk into the clay below, so as to withstand the later grinding, polishing and striation.

THE TORONTO FORMATION.

After the recession of the first ice sheet there was a long period of erosion and river action, in places removing the boulder clay and cutting down into the shale. Afterwards a great lake filled the basin, laying down the beds of clay, sand and gravel of the Toronto Formation upon the eroded surface.

The Toronto Formation is naturally divided into two parts, the lower being the Don beds and the upper the Scarboro beds. These two divisions differ greatly in their fossils and were formed under different climatic conditions, the Don beds including fossils proving a warmer climate than the present and the Scarboro' beds others that indicate a cooler climate. The two are never well displayed in the same exposure, but the order of succession is certain, and there are places which show the Don beds underlying conformably the lowest portion of the Scarboro' beds. Both were probably delta deposits, though of different types; but in the western part of Toronto there are interglacial beds having the tumultuous cross bedding and irregularity characteristic of strong currents and probably formed by a large river. The exact position of these beds with reference to the others is not quite certain, though they belong to the same interglacial period.

THE DON BEDS.

The best outcrop of the Don beds is to be found just north of the shale pit referred to before in the Don Valley brickyard, to the east of Rosedale. The Pleistocene section is 130 feet in thickness and includes not only the Don beds, but an overlying series of unfossiliferous clays which were formed much later when the ice front was not far off.

The section is divided into three parts corresponding to the three working levels of the clay pit, and rises to the Iroquois terrace.

Resting on the shale there are three feet of boulder clay, followed by from 14 to 17 feet of stratified materials, consisting of a foot or two of bluish clay below and brown or yellow sand with thinner clay beds above, the whole somewhat irregularly distributed probably by a river coming into a lake 60 feet higher than lake Ontario at present.

Interglacial Beds at Bend of Don River.

This exposure is highly fossiliferous, some beds being crowded with shells, while flattened trunks and branches of trees often occur, and in one thin layer of clay, now run out, many leaves of trees have been found.

Ascending above this part of the section one must go about 50 feet farther north to find its continuation. The next bed is of blue clay 3½ feet thick above which there are five feet of yellow and brown sand, the last member of the characteristic Don beds. The total thickness above the lower boulder clay is from 23 to 25 feet. The brown

sand was evidently deposited in shallow water where oxidation was taking place, since some of the coarser beds of gravelly sand in the section are cemented with limonite.

Bluish gray finely laminated clay, overlying the Don beds conformably to a thickness of from 7 to 22 feet, was laid down in much deeper water, and shows no fossils except a little peaty matter. It represents the lowest part of the Scarboro beds.

A thin sheet of boulder clay, the second in order, rests upon the eroded surface of the stratified clay just mentioned, followed by 80 feet of rather coarsely laminated clay sometimes containing subangular striated stones. The source from which this clay was derived must have been the ice margin not many miles away. The lower stratified clay, which is interglacial, is formed of well leached material and burns to red brick; while the overlying stratified clay is so strongly charged with lime as to burn to a buff brick.

The top of the section consists of a few feet of brown sand and loam with large boulders, resulting from the wave work of lake Iroquois. The stones have evidently been washed out of an overlying sheet of till, which may still be seen in the old shore cliff half a mile to the north.

The lower 25 feet of Don interglacial beds are crowded with fossils and form the most important part of the section. From them wood or leaves of thirty-two species of trees have been obtained and forty-one species of shell-fish, of which twelve are unios or anodons, in addition to undetermined beetles, cyprids, etc.

The following list of interglacial plants was supplied by the late Professor Penhallow:—

Acer pleistocenicum.
" *spicatum.*
" *torontoniensis.*
Asimina triloba.
Carya alba.
Chamæcyparis sphæroidea.
Clethra alnifolia.
Crategus punctata.
Cyperaceæ sp.
**Drepanocladus capillifolius.*

---

*Determined by Mr. A. J. Grout.

Eriocaulon sp.
Festuca ovina.
Fraxinus quadrangulata.
" *sambucifolia.*
" *americana.*
Gleditschia donensis.
Hippuris vulgaris.
Hypnum sp.
Juniperus virginiana.
Larix americana.
Maclura aurantiaca.
Ostrya virginica.
Picea nigra.
" sp.
Pinus strobus.
Platanus occidentalis.
Populus balsamifera.
" *grandidentata.*
Prunus sp.
Robinia pseudacacia.
Quercus obtusiloba.
" *alba* (?).
" *rubra.*
" *tinctoria.*
" *oblongifolia.*
" *macrocarpa.*
" *acuminata.*
Salix sp.
Taxus canadensis.
Thuya occidentalis.
Tilia americana.
Ulmus americana.
" *racemosa.*
Vaccinium uliginosum.
Chara.

Inadvertently he included two specimens from the Scarboro beds some miles to the east, *Picea nigra* and *Larix americana,* belonging to a later and cooler stage of the interglacial period.

The shell-fish were determined a number of years ago by Dr. Dall and his assistants at the Smithsonian institution, the list being as follows:—

Unio undulatus " *rectus* " *luteolus* " *gibbosus*	Still living in lake Ontario.
" *phaseolus* " *trigonus* " *coccineus*	Still living in lake Erie, but not reported from lake Ontario.
" *occidens* " *solidus* " *clavus* " *pyramidata*	Not known in the St. Lawrence system of waters, but living farther south.

Anodonta grandis.—Not reported from Canada.
Sphærium rhomboideum.
" *similis* (?).
" *solidulum.*
" *striatinum.*
" *sulcatum.*
Pisidium adamsi.
" *compressum.*
" *novaboracense* (?).
Pleurocera subulare.
" *elevatum.*
" *lewisi* (?).
Goniobasis depygis.
" *haldemane.*
Limnæa decidiosa.
" *elodes.*
" *bicarinatus.*
Planorbis parvus.
Amnicola limosa.
" *porata.*
" *sagana.*
" *ancillaria.*
Physa heterostropha.
Succinea avara.
Bithinella obtusa.
Somatogyrus isogonus.

Valvata sincera.
  " *tricarinata.*
Campeloma decisa.
Bifidaria armata (land snail).

Of mammals the Don Valley brickyard has supplied a bone of a large bear and bones or horns of bison, of a deer like the Virginia red deer, and of a deer related to the caribou.

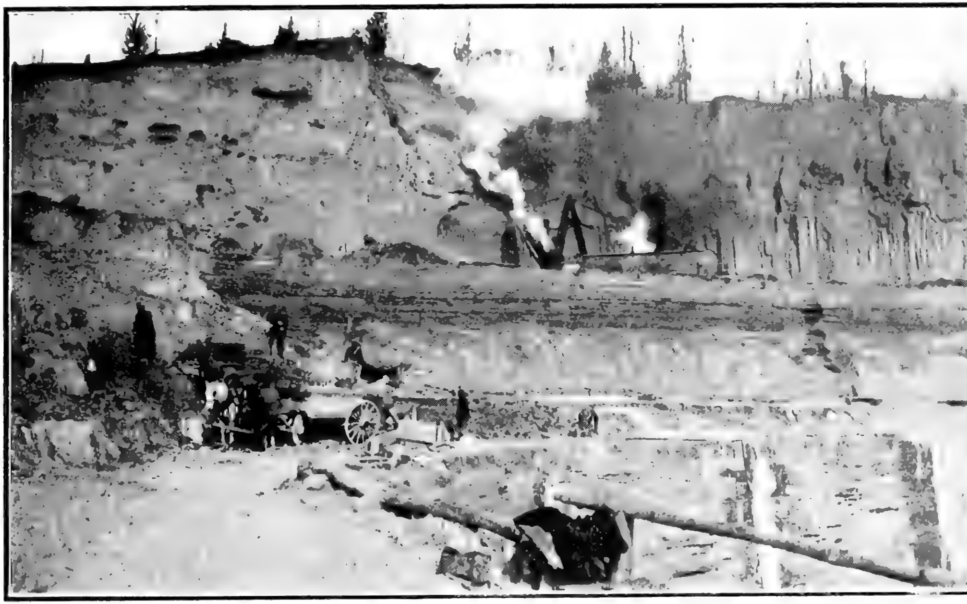
Of the trees, seventeen are near their northern limit and scarcely reach Toronto at present, while ten or eleven of the unios and other shell-fish do not now live in lake Ontario, but inhabit Mississippi waters. The whole assemblage of plants and animals implies a warmer climate than the present, such as that of Ohio or Pennsylvania, as suggested by Prof. Penhallow and Mr. White. There could have been no great ice sheet within hundreds of miles of the region when the rich Don forest grew, with its pawpaws, osage oranges and red cedars.

A walk of half a mile up the Don valley to a second brickyard, just beyond a bend of the river, discloses another section of the Don beds of a somewhat different kind. To the west of the valley Lorraine shale rises 16 feet above the river, followed by boulder clay, on which rests sand with unios like the deposits just described. Two hundred yards to the east the shale can be seen rising eight or ten feet, but between these two points the boulder clay and shale were cut away by an interglacial river, which afterwards began to deposit materials on the shale in the rising waters of a lake.

At the base of the section there are three or four feet of coarse shingle mixed with matted reeds, leaves and wood. Above this there are eleven feet of sand and clay with many shells. The whole is covered by a few feet of recent sand deposited by the Don before its bed had been cut as low as at present. The trees include red cedar, elm, oak and pawpaw, showing that the climate was warm at the earliest stage of the Don beds.

If we add these lower beds to the better exposed section at the Don valley brickyard the total thickness is 40 or 45 feet.

Similar beds of sand and clay containing wood and unios are found at several places along the Don for about



Don Valley Brickyard.

two miles to the south, and wood and shells have been obtained from excavations and wells at many points in the city to the west and below the level of the lake at Scarboro also, so that the Don beds cover several square miles, though the exact boundaries are not known.

A deposit of sand and gravel containing wood and shells has been found near Thornhill, fourteen miles north of lake Ontario, while boring for water. It underlies 200 or 300 feet of clay, and is no doubt the northward extension of the Don beds along the channel of the interglacial river which formed the delta.

THE SCARBORO BEDS.

The upper interglacial beds at the Don valley brickyard, consisting of laminated clay with no fossils except peaty materials, are found at several outcrops to the north and northwest, growing thicker in those directions and reaching, north of Reservoir park, an elevation of about 150 feet above lake Ontario. They are also found to the east of the Don and at Scarboro heights, where they are best exposed. In the brickyard 672 laminæ were counted in a height of 19 feet 9 inches, probably representing as many years of deposition. Above this a foot or two were too much broken up by the later ice advance to be counted. The counting was done by Baron de Geer's method, devised for the marine clays of Sweden, the limits of the layers being marked on strips of paper.

Since the Scarboro cliffs give the best opportunities for the study of these beds, they will be described as typical. The splendid Scarboro section was worked out by Dr. George Jennings Hinde many years ago, demonstrating the first series of interglacial beds recognized in America. His work was so good as to require scarcely any change in later times. At Scarboro the Don beds are not visible in the cliffs, but wells sunk on the beach show that they exist a few feet below the lake and have a thickness of 36 feet. They consist of yellowish sand with some beds of clay, containing unios and pieces of wood as in the Don sections.

Above the water level, where the interglacial section is most complete, there is not only laminated clay like that referred to above, but also a great thickness of sand resting upon it.

The thickest section includes 36 feet of Don beds and 5 feet of peaty clay below water, with 85 feet of peaty clay above water followed by 55 or 60 feet of stratified sand, making in all 186 feet of interglacial beds. The general section shown in the cliffs will be described first, and then the fossils will be taken up.

THE SCARBORO SECTION.

At Victoria park, toward the east end of Toronto, the flat sandy shore ends and boulder clay shows above the water, standing up as a comparatively low cliff capped with Iroquois sand beds. Toward the east the cliff rises and becomes more complex in structure until it reaches a height of 355 feet four miles from Victoria park, after which it descends and finally reaches lake level at Highland creek, 9½ miles from its commencement. This fine section shows not only the greater part of the interglacial beds, but a series of four tills with interbedded stratified sand and clay, and also nearly 100 feet of Iroquois sands towards the western end. The upper series of boulder clays and interstratified beds is confined to a small part of the section at its highest point. To the east and west of this only one sheet of boulder clay can be seen, but it stretches almost continuously along the upper part of the section, though with great variations in thickness.

It is evident that the interglacial beds were greatly eroded by river action before the second ice advance, as may be seen at the "Dutch Church," where a river valley was cut to a depth of 166 feet, having a width of 1,200 feet at lake level and nearly a mile on top. The layer of boulder clay, after rising to 150 feet, rapidly dips down to the level of the lake at this point and then rises again beyond it. This is in reality the second sheet of till in the succession, the lowest one being 40 feet below the lake, underlying the unio beds mentioned above.

The waves of lake Ontario undercut the cliff, especially in seasons of high water, after which slices slip down and are removed by storms. Where there are several successive years of low water in the lake much of the face of the cliffs becomes covered with vegetation, though they are too vertical in the neighborhood of the Dutch Church to permit of much plant growth. The earliest reliable survey of Scar-

The "Dutch Church," Scarboro

boro was made fifty years ago, and another survey made during the past year shows an annual recession of 1.62 feet per annum. The boulders from the boulder clay remain at the base of the cliff, when not removed by man, and the interglacial sands when washed by the waves on the shore show thin sheets of red garnet or black magnetite.

The interglacial clay rising about 85 feet above the lake has certain well marked features. It is often well stratified in laminæ running from a fraction of an inch to two or three inches in thickness, though there are a few layers three or four feet thick in which the bedding is indistinct or wanting. Where typically bedded each lamina consists of a darker layer of fine gray clay, and a paler part of a silty nature. Often the silty part widens and contains more or less peaty matter with mica scales. Occasionally the peaty bands expand to half an inch or an inch in thickness, and rarely twigs or small bits of wood are found. Every few feet in the section shows a thin sheet of impure siderite which stands the weather better than the rest of the beds and is broken on the beach into flat shingly pebbles, which slowly oxidise to limonite. The iron ore and the peaty layers make distinctive features by which this interglacial clay is easily recognized. It burns to a red brick.

From the peaty matter mosses, bits of leaves and bark, seeds and parts of beetles may be obtained, by washing away the clay, drying the peat and examining it with a lens. The late Dr. Scudder, of Harvard University, determined seventy-two species of beetles from materials obtained here, the list being as follows:

FAUNA OF COOL CLIMATE, CHIEFLY FROM SCARBORO.

Arthropoda (almost wholly beetles):
Carabidæ (9 gen. 34 sp.).
Elaphrus irregularis.
Loricera glacialis.
" *lutosa.*
" *exita.*
Nebria abstracta.
Bembidium glaciatum.
" *Haywardi.*
" *vestigium.*
" *vanum.*

Bembidium præteritum.
" *expletum.*
" *damnosum.*
Patrobus gelatus.
" *decessus.*
" *frigidus.*
Pterostichus abrogatus.
" *destitutus.*
" *fractus.*
" *destructus.*
" *gelidus.*
" *depletus.*
Badister antecursor.
Platynus casus.
" *Hindei.*
" *Halli.*
" *dissipatus.*
" *desuetus.*
" *Hartii.*
" *delapidatus.*
" *exterminatus.*
" *interglacialis.*
" *interitus.*
" *longævus.*
Harpalus conditus.

Dytiscidæ (3 gen. 8 sp.).
Coelambus derelictus.
" *cribrarius.*
" *infernalis.*
" *disjectus.*
Hydroporus inanimatus.
" *inundatus.*
" *sectus.*
Agabus perditus.

Gyrinidæ (1 sp.).
Gyrinus confinis, LeG.

Hydrophilidæ (1 sp.).
Cymbiodyta exstincta.

Staphylinidæ (11 gen. 19 sp.).
Gymnusa absens.
Quedius deperditus.
Philonthus claudus.
Cryptobium detectum.
" *cinctum.*

Lathrobium interglaciale.
" *antiquatum.*
" *debilitatum.*
" *exesum.*
" *inhibitum.*
" *frustum.*
Oxyporus stiriacus.
Bledius glaciatus.
Geodromicus stiricidii.
Acidota crenata, Fabr. (var. *nigra.*).
Arpedium stillicidii.
Olophrum celatum.
" *arcanum.*
" *dejectum.*

Chrysomelidæ (1 gen. 2 sp.).
Donacia stiria.
" *pompatica.*

Curculionidæ (4 gen. 6 sp.).
Erycus consumptus.
Anthonomus eversus.
" *fossilis.*
" *lapsus.*
Orchestes avus.
Centrinus disjunctus.

Scolytidæ (1 sp.).
Phloeosinus squalidens.

Of these all but two are extinct, as stated by Dr. Scudder.

Mr. A. J. Grout has determined the following mosses from the same beds:—*Hygrohypnum palustre* (?), *Drepanocladus vernicosus* (Lindb), and *Hylocomium* sp.

The Scarboro interglacial sands are less extensive than the clays just described, since they are the uppermost beds and suffered far more from superficial destruction by rain action and river erosion in the later part of the interglacial interval.

Where best developed the sands have a thickness of 55 or 60 feet, the lower four or five feet having clayey layers showing a transition to the peaty clay. The sand is generally coarse, but free from pebbles, and some layers are cross-bedded, showing that the deposit was made in shallow water.

There are in some places many concretions of brown iron ore, once no doubt, siderite.

Toward the bottom of the sand and immediately above the clay there is often a thick bed of coarse peaty materials, including many chips of wood and bark and bits of branches. The trees recognized are *Larix Americana* and *Abies balsamea.* A few small shell-fish are found also, *Sphærium rhomboideum, S. fabale, Limnæa* sp., *Planorbis* sp. and *Valvata tricarinata.*

The sand extends for five miles along the cliffs and has been found in ravines several miles north of the shore.

The Scarboro interglacial beds were formed in a northern bay of an interglacial lake, which reached at least ten miles inland from the present shore. They are delta deposits laid down by a great river coming from the Georgian bay region, draining the basins of the present upper lakes, and they began with a water level somewhat below that of lake Ontario.

Above the second till sheet there is stratified clay and sand, followed by a third sheet of till, and in the highest part of the cliffs a fourth and a fifth sheet of boulder clay have been found with intervening stratified sands and clays. There were three well-defined recessions of the ice during which lake deposits having thicknesses of from 25 to 36 feet were deposited. How long these later interglacial periods lasted is unknown. No important erosion intervals are known in connection with them, and except for a few small shells in one of the beds they are without fossils; so that they seem to have been of much less importance than the Toronto interglacial period.

The total thickness of these upper glacial and interglacial deposits at the highest point of the Scarboro section is 203 feet.

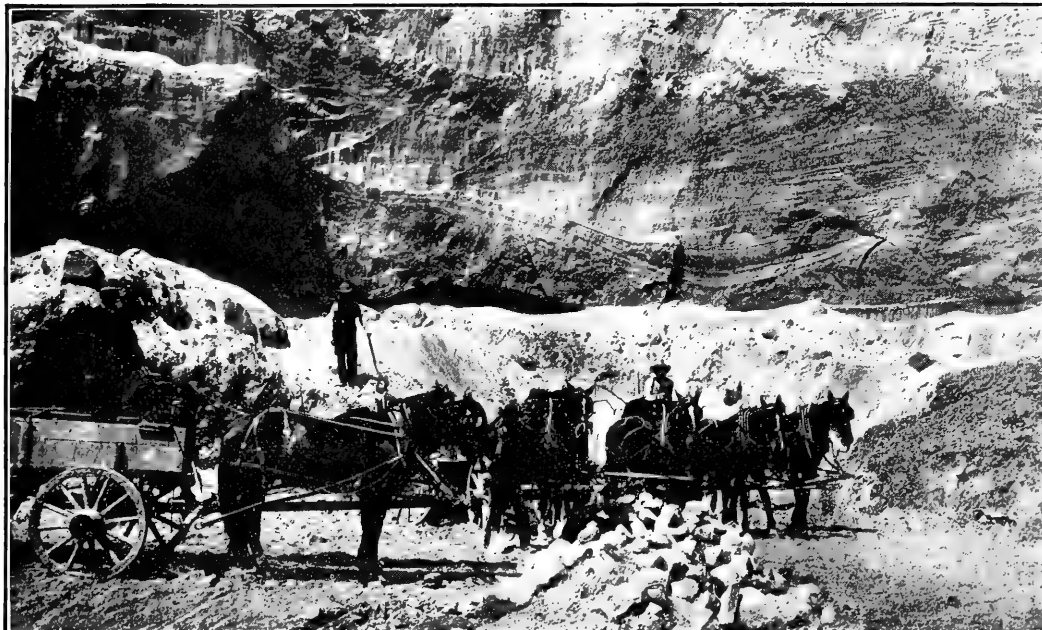
The magnificent Scarboro section may be seen to the best advantage by taking a King street car as far east as possible and then walking eastwards along the shore. This, however, demands a good deal of time, and the highest and most interesting parts of the section may be seen more expeditiously by taking a King street car to the Woodbine and there transferring to a suburban car running along Kingston road. This ascends the sandy slopes of the long spit which enclosed the ancient Don bay of lake Iroquois, and then runs for two miles east along the old gravel bar, which

is well disclosed by numerous gravel pits. The road then climbs the Iroquois shore cliff to the gently rolling upland of boulder clay. At stop 32 a lane leads south from Kingston road past a Topographical Survey tower to the edge of the cliff, a distance of about three-quarters of a mile. The highest point on the actual shore of lake Ontario is reached a short distance to the east. From this point, 355 feet above the lake, there is a steep descent, mostly through a small growth of trees to the shore. The section described above is shown in bare cliffs on each side of the path, a sheet of boulder clay, followed by stratified clay and sand, another sheet of boulder clay, succeeded by silty sand with its upper layers crumpled by the advancing ice, a third comparatively thin sheet of boulder clay with cross-bedded sand beneath it, and a fourth boulder clay resting on the eroded sand beds of the great interglacial formation, under which the peaty clay extends to the shore of lake Ontario.

The section has been worked out as follows:

		Feet.	
Boulder clay, No. 5		48	Glacial Complex, 203 feet.
Stratified sand and clay		36	
Boulder clay, No. 4		32	
Silty sand, upper layers crumpled		25	
Boulder clay, No. 3		9	
Cross-bedded sand		29	
Boulder clay, No. 2		24	
Scarboro Interglacial beds	Sand	59	Above level of lake Ontario, 151 ft.
	Peaty clay	92	
Don beds (unios and wood)	Peaty clay	5	Below level of lake Ontario, 41 ft.
		36	
Boulder clay, No. 1			
Lorraine shale			
Total Pleistocene beds			395

A walk of less than a mile westwards along the beach brings one to the "Dutch Church," where an interglacial river valley has been filled with the second boulder clay followed by stratified glacial clay. The gradual rise of the boulder clay on each side of the fossil valley is well exposed.



Shaw Street Sand Pit.

The steepest cliffs of the section are cut from this thick mass of hard clay which stands vertical to a height of 150 feet. Small streams coming in have cut extraordinary ravines, one of them with the aid of rain erosion shaping the tower and buttresses of the "church." A stairway leads up 170 feet from the shore at the Dutch Church to the Iroquois terrace, here beautifully displayed with a shore cliff more than 100 feet high; and a walk of three-quarters of a mile brings one to the Kingston road, at Half-way House, where a car may be taken to the city.

INTERGLACIAL BEDS IN THE WESTERN PART OF TORONTO.

The order of succession and relative ages of the deposits thus far described are well ascertained, but in the western part of Toronto, north of Bloor street and near Christie and Shaw streets, there are fossiliferous beds of uncertain position. Eighty feet of tumultuously cross-bedded sands and gravels here underlie the second till sheet, so that they are clearly interglacial; but they differ so much in character from both the Don and Scarboro beds that they cannot be classed with either. They were evidently formed by a powerful river which sometimes deposited coarse materials in its bed and then cut them away again by some shifting of its channels, a type of work quite different from the quiet deposit of clay and sand in the interglacial delta of the Don and Scarboro sections. They may be older than the Don beds or younger than the Scarboro beds.

These western beds contain a few fragments of unios as well as *Sphæriums, Pleuroceras* and other small shells, all of which occur in the Don beds. A little wood found in these sand pits is still undetermined. The most interesting fossils obtained are scattered bones of mammals, including bison, deer and mammoth or mastodon. A horn of *Cervalces borealis,* as determined by Prof. Bensley, an atlas vertebra of bison and part of a lower jaw of a bear (O. P. Hay) have been found also, and several fragments of ivory have been picked up. All of these remains seem to have been waterworn and may have been transported for some distance. There is no certain evidence as to climate in the fossils thus far found.

From the lists given above it will be seen that the Toronto Formation has furnished a wide range of fossils,

Christie Street Sand Pit (Interglacial). Upper Boulder Clay to Right.

including 42 trees and other flowering plants with several mosses, 41 shell-fish, 72 insects, and 5 or 6 mammals—about 165 or 170 species all told.

OUTLINE OF CLIMATIC AND PHYSICAL CHANGES.

The Toronto interglacial period included great changes in climate and in physiographic features. During the retreat of the first ice sheet no doubt the climate slowly changed from Arctic to subarctic and finally to temperate, and probably the valley was at first occupied by a great glacial lake when thawing had proceeded so far as to free the basin, but not its outlet toward the northeast. These earlier stages of the interglacial time have left no visible record, though they must have required thousands of years to accomplish.

The first episode in the Don beds shows a river flowing into a lake lower than the present, with a rich deciduous forest on its shores. There followed a rise of water in the lake, probably by the upwarping of its outlet, to 60 feet above the present level. This time of warm climate lasted long enough for the deposit of 45 feet of sand and clay in a delta several square miles in area, and for the growth of generations of forest trees.

At length there came a rise of the waters to 150 feet or more above the present lake, when delta beds were laid down covering more than 100 square miles. At one point there are 672 annual layers in less than 20 feet, so that the whole thickness must have required some thousands of years to deposit. The climate had become colder, as shown by the plants and insects, and was like that of northern Ontario at present.

Next, the great lake was drained to a level 16 feet below lake Ontario, and three river valleys were carved in the delta, a wide one toward the west at the present site of Toronto, a narrower one at the Dutch Church and another wide one towards Highland creek. These valleys had gently sloping sides and were much more mature than the present valleys of the Don and the Humber. To cut them the rivers must have required several thousand years.

Finally, Arctic conditions came on and the ice advanced once more from the northeast, covering the eroded surface of the region with a second sheet of boulder clay. The climatic cycle was complete.

THE IROQUOIS BEACH DEPOSITS.

After the last ice age, when the retreat was well under way, the basin of lake Ontario was freed from ice while its outlet at the Thousand islands was still blocked. The water escaped by the Rome outlet, in the State of New York, to the Hudson, and a lake which has been named Iroquois by Dr. Spencer, occupied the basin at a much higher level than that of lake Ontario. The southern slope of Toronto is largely covered with its deposits, the old shore cliff runs east and west through the city, and at each end a great gravel bar extends across the present river valley.

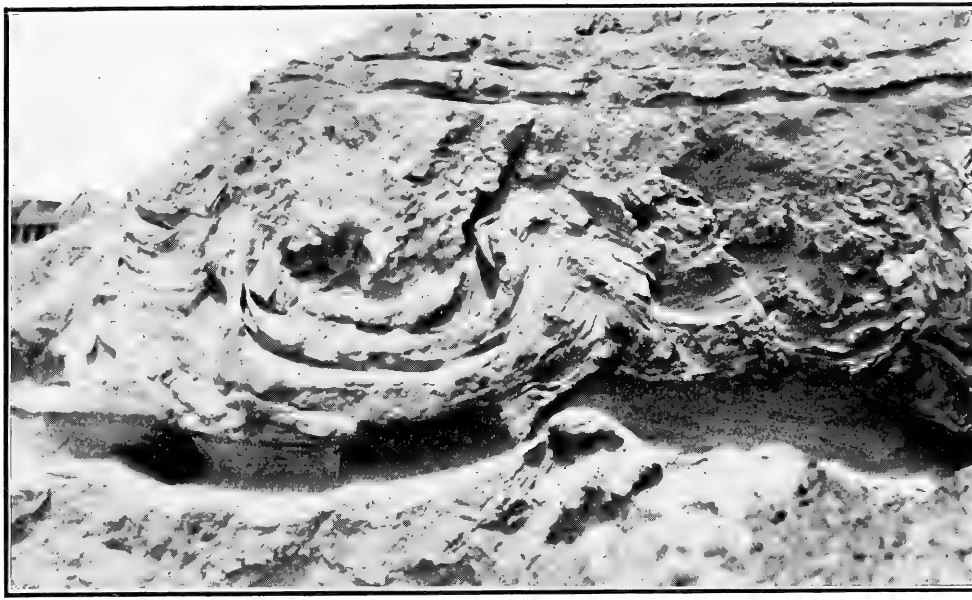
The Iroquois beach is deformed and rises from 176 feet above lake Ontario at the Humber gravel bar toward the west to 196 feet at the York gravel bar crossing the mouth of the ancient Don bay, and to 200 feet at Scarboro heights. The shore cliff within the city north of Davenport road averages about 75 feet in height, but at Scarboro reaches in places 170 feet. At the highest point of the Scarboro cliff it is completely cut off by the shore of lake Ontario for half a mile, the only known point at which the waves of Ontario have encroached on the ancient shore line.

Lake Iroquois began its work at least 70 feet below its latest well marked beach, but none of the earlier stages is shown at Toronto. Beside the cutting of a terrace in the Pleistocene deposits with the cliff at its rear the lake did much work in distributing materials, filling in former depressions in the terrace, and building the two great gravel bars in west and east Toronto respectively. Each of these bars began on the east side of its bay and grew westwards, crowding the river out of its earlier channel and forcing it to the western shore of the bay.

The bar in west Toronto crossing the Humber bay extends west as a uniform and rather narrow ridge of gravel and sand rising 20 feet above the slope to the south, while the York (or east Toronto) bar enclosing the Don bay is more spread out and contained lagoons. It had much the size and shape of the present Toronto island.

Both of these ancient bars are being rapidly destroyed, the sand and gravel being used for building purposes in Toronto.

The Iroquois deposits are sometimes 100 feet thick and include coarse materials in the gravel bars, sand of varying



Crumpled Beds (Iroquois Deposit) Near Pape Ave.

character on the lakeward slope, as well as silt and clay within the Don and Humber bays. At one point near Reservoir park shells have been found in the gravels, species of *Campeloma, Pleurocera* and *Sphærium,* all still living in lake Ontario. The commonest fossils are horns of caribou, which are often found in the west Toronto gravel bar. Less frequently teeth of mammoth have been obtained. The mammoth and the caribou suggest a cooler climate than the present. The caribou is essentially a northern animal, and has not been found within 150 miles north of Toronto during historic times. It is natural to suppose that the waters of lake Iroquois, which had a shore of ice toward the northeast, were colder than those of Ontario, and that the climate was cool, if not even subarctic.

When lake Iroquois was drained through the melting of the ice dam at the Thousand islands, the water sank to sea level, but there is no evidence of marine deposits on its shore. The marine episode was comparatively short and the water was probably kept fresh by the Niagara river. The outlet was still rising toward the northeast, so that the water was backed up toward the southwest end of the lake. On the lower reaches of both the Don and the Humber there is dead water owing to this rise of the lake level, and well borings near the mouth of the Don show 100 feet of stratified sand built up in the old channel. The growth of Toronto island is, however, the most evident work of lake Ontario near Toronto in recent times. Its materials have been transported westwards from Scarboro heights, and have been built out into deep water enclosing Toronto bay, The growth of the island has been shown by Sir Sandford Fleming, from a comparison of maps more than 100 years old, to have been extensive.

EXCURSION B 5

MORAINES NORTH OF TORONTO

BY

FRANK B. TAYLOR.

The moraines to be visited on this excursion were made at a relatively late stage in the retreat of the last or Wisconsin ice sheet, and are the first moraines formed north of lake Ontario. One was made along the southern edge of the Trent valley-lake Simcoe ice lobe. At the locality visited the ice which made this moraine, was moving towards the south and the moraine faces in that direction. The main movement in that lobe, however, was towards the southwest, shown by the axes of many drumlins and drumloids and by striæ and the direction of boulder transportation in the Trent valley and lake Simcoe regions. The direction in this area was about the same during the maximum extent of the ice and during the whole time of its retreat. The other moraine to be visited lies close south of the first and was formed along the northern edge of the ice lobe which lay in the basin of lake Ontario.

At the greatest extent of the ice sheet, its front reached nearly to Cincinnati, Ohio, about 400 miles southwest from Toronto. The ice which reached this point was part of the great ice stream which moved southwestward through the basins of lakes Ontario and Erie. At the same time the ice front in a direction south-southeast from Toronto reached only to Salamanca, New York, about 120 miles from Toronto. This was on account of the Alleghany plateau, the high mass of which obstructed the southward movement in western New York and Pennsylvania and in northeastern Ohio, and turned the current towards the Southwest along the axis of the lake basins. The central axis of the great ice stream passes about 30 miles south of Toronto, and there was not much change in its position dur-

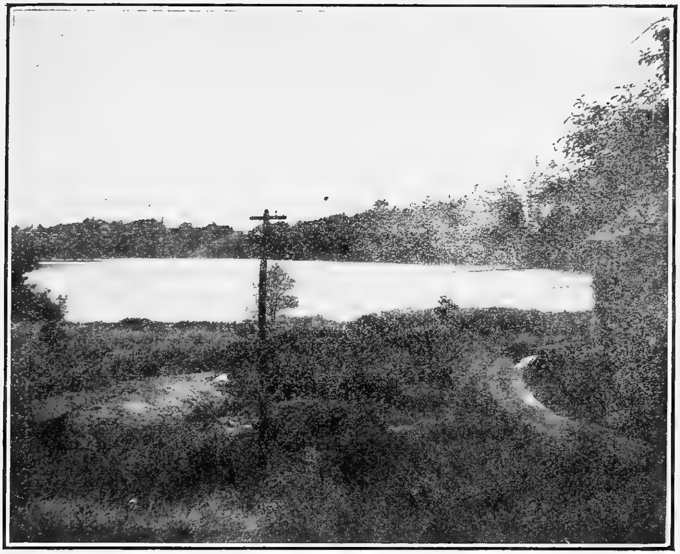
ing the retreating phase, until the ice front had receded to the northeast end of lake Erie. By the time it had reached this position, however, the relatively deep basin of lake Ontario became the controlling factor in the ice movements of this region. This was the position of the ice front a short time before the moraines to be visited were made. The ice field was then confluent and continuous over the whole region between the lake Ontario basin on the south and the Trent valley, the lake Simcoe basin and the basin of Georgian bay on the north. At this time the ice front rested against the face of the Niagara escarpment from Hamilton northward to Georgian bay, and the ice lay as an unbroken sheet over the whole region to the east. It was already growing thin, however, over the ridge north of Toronto, and with further steps of retreat the ice soon parted and the ridge began to emerge.

The first parting of the ice lobes in the manner described probably occurred during the time of lake Arkona, but was temporary, for the pronounced readvance of the ice to the Crystal beach (Alden, Port Huron) moraine carried the ice front back again to the base of the escarpment, and the moraines which had just been made were overridden and destroyed. This episode of glacial history is not established on evidence seen in the localities visited on this excursion, but is fully supported by facts recorded in other parts of Ontario and in Michigan and New York. Then, when the ice front retreated again, the ridge was once more uncovered and the moraines now seen on the heights 20 miles north of Toronto began to be formed. This was probably during the times of lakes Wayne and Warren, but later phases farther east were probably correlatives of lake Lundy.

The two moraines were formed on the top of the emerged ridge, first at the west end near the base of the Niagara escarpment, and later at places farther east. As the flanks of the ridge were gradually uncovered, lake waters stood high upon them, but these waters were only narrow arms that reached northward from the main lake in the basin of lake Erie and made no perceptible record by wave action.

At this stage of retreat the ice did not enter the western part of the lake Ontario basin over the ridge north of Toronto, but came in at the northeastern end chiefly in the gap between Trenton, Ontario, and Oswego, New York.

At this time the lake Ontario ice lobe had become sharply differentiated, so that in the western half of the basin the ice was spreading from the central axis towards the margin on all sides except the east, where the ice stream was entering. From this circumstance it happens that the ice at this stage moved towards the northwest over Toronto and vicinity. A few miles east of Toronto its movement was directly north. These movements were respectively transverse and nearly



Bond Lake, Looking East. Probably Due to Partly Buried Ice Block Which Afterwards Melted Out.

opposite to the southwestward movements over this region at the time of maximum extension. The relations in this area afford a fine illustration of the changing and increasing influence of topography upon the movement of the ice as the ice grew thinner.

The drift, as Professor Coleman has pointed out, is quite deep in the vicinity of Toronto. But it is certainly much deeper along the line of the great moraines 20 miles to the north; and its depth is also considerable in the region west and southwest of lake Simcoe. Much the greater part

of the deep drift in the region around Toronto is of pre-Wisconsin age, but beyond this general statement its precise age has not been determined even approximately, except by Coleman, in the remarkable exposures in Toronto. It is quite clear, however, that the pre-Wisconsin beds or some of them, have a wide extension in easterly, northerly and northwesterly directions from Toronto. In many localities the Wisconsin drift is only a thin sheet, sometimes even discontinuous, over a great mass of the older drift. The bulky moraines north of Toronto appear to rest upon a deep substructure of these older deposits.

Suburban cars leave the Toronto and York Radial station on North Yonge street. The station stands a little below the level of the beach of glacial lake Iroquois, and the car ascends the old lake cliff immediately after leaving the station. On reaching the top, the traveller finds himself on an undulating plain trenched by small streams running toward the southeast. The stream valleys have been cut to only moderate depths, the deepest being the west branch of the Don river, which at York Mills reaches a depth of about 100 feet.

The surface forms that meet the eye as soon as the car leaves the old lake bluff are readily recognized as products of glacial action, perhaps partly constructional, but mainly destructional in character—a smoothing and rounding off of an uneven surface by the ice sheet. In the first mile or two several hills resembling drumlins are seen, none of them perfect types, however, but sufficiently near to be called drumloid forms. Glacial action is not recorded alone in these hills, for the whole surface is characterized by long drumloid profiles on the interstream ridges, and the troughs have the same character, and both troughs and ridges are strongly alined after the fashion of drumlins in the direction of the latest ice movement. This kind of surface has been happily characterized by Fairchild as "drumlinized," meaning by this that the drumlin-forming process gave the surface its character, although no perfect drumlins were formed.

At York Mills the sands in the high bank south of the Don river and west of the track are reported by Coleman to be of pre-Wisconsin age. Between York Mills and Richmond Hill several partially drumlinized forms are seen towards the east. At Thornhill a bored well penetrated 600

feet of drift, or about to sea level, before reaching rock. A large part of the material was reported to be sand.

Approaching the moraine north of Richmond Hill, the drumloid forms disappear and the plain merges smoothly into the southern slope of the moraine. This slope is notably smooth and lacks the hummocky surface which usually characterizes terminal moraines. The southern margin takes this form all along from King southward to Maple and then northeastward and eastward for 100 miles.

A Pond and Morainic Topography in the Northern Moraine, Looking South Three Miles West of Aurora.

This smooth slope is the side on which the ice front rested while building the moraine. The moraine, therefore, faces northwest and north, its north side being its front slope and its south side its rear.

On reaching the summit of the ridge this and the northward slope are found to be more irregular and hummocky than the south slope, more characteristic of ordinary terminal moraines. There are many knobs and basins, and within two miles there are three moraine lakes and several similar hollows that do not now contain lakes. The car

line passes along the west side of Bond lake and the party will walk northward from the power house to Schomberg Junction, noting the very steep slopes bordering this lake and the rugged nature of the ground, and also the sections of the drift exposed along the newly-made highway. Much of the drift in the north slope of the moraine is more or less sandy, suggesting glacio-fluvial deposition, but no extensive bodies of outwash are associated with the moraine in this vicinity. The south or rear slope, in addition to the smoothness described above, is more generally composed of till and shows almost no evidence of glacio-fluvial action. Some of the lakes and basins are no doubt due merely to the irregular heaping of the drift during deposition by the ice, but some, like Bond lake, appear to mark the sites of ice blocks surrounded or partly buried by drift, the lake basin remaining when the ice melted out.

From the Junction one looks to the north and west across a flat valley half a mile to a mile wide, and just beyond it lies a splendid moraine formed by ice moving southward over the lower region to the north. The flat valley is a narrow till plain lying between two moraines that face toward each other. It extends eastward from the Junction to Willcocks' lake, which lies partly in the southern moraine. but mainly in the plain. The party will walk eastward from the Junction along the south side of the plain, gradually ascending the front of the southern moraine and passing along the south and east sides of the lake. From the lake shore the valley is seen to pass on towards the northeast and north. It extends in this direction for about a mile, to where it appears to vanish into the air. But a glacial drainage course marked by a train of sandy gravel comes from the outwash area to the east and appears to connect with it. Northeast of the lake the valley has the character of a large drainage channel or old river bed lying between the two moraines, which form its banks on either side. In the early phase of this pause of the retreating ice, a large river issued from the narrow space between the two ice fronts and flowed out to the west. This river carried the accumulated drainage from a long way to the east and northeast. There are low sand and gravel beds on the valley floor north and northeast of the lake that record the action of the river.

The main bulk of the gravels, however, lies at a slightly lower level than the head of the channel, and marks a change of the drainage by which it continued along the rear side of the northern moraine to another slightly lower passage farther west. Such a passage occurs about eight miles west of Aurora or one mile east of Linton, and the gravels appear to end at that place. Outwash gravels form the crest of the hill along the north side of the creek for two miles west from Van Dorf.

Looking North Over Willcocks' Lake, the Northern Moraine in the Distance

These old river gravels form a sort of terrace along the north or rear slope of the north moraine. It is well defined where the electric line crosses it at the cemetery a mile south of Aurora.

The deposit stands considerably above the lower country to the north. It is cut by many small gullies, but is substantially continuous from the large outwash deposit six or seven miles east of Aurora to the gap east of Linton. This deposit is not outwash issued from the front of the ice while the moraine was being built, for it rests on the rear slope

of the moraine. It appears to have been deposited by a river flowing westward along the ice front in the last or closing phase of the relatively long pause during which the moraine was built. The ice had ceased advancing apparently and had become practically inert along its edge. The river during this phase had fallen a little below the passage to Willcocks' lake and probably escaped southward through the gap east of Linton.

Two miles east of Willcocks' lake there are well-developed eskers and associated troughs cutting through the southern moraine from southeast to northwest. These also show with great clearness that the ice here was moving toward the northwest, normal to the trend of the moraine at this place. The esker stream cut through the moraine and issued into the drainage channel a mile and a half northeast of Willcocks' lake.

EXCURSION B 6

MUSKOKA LAKES

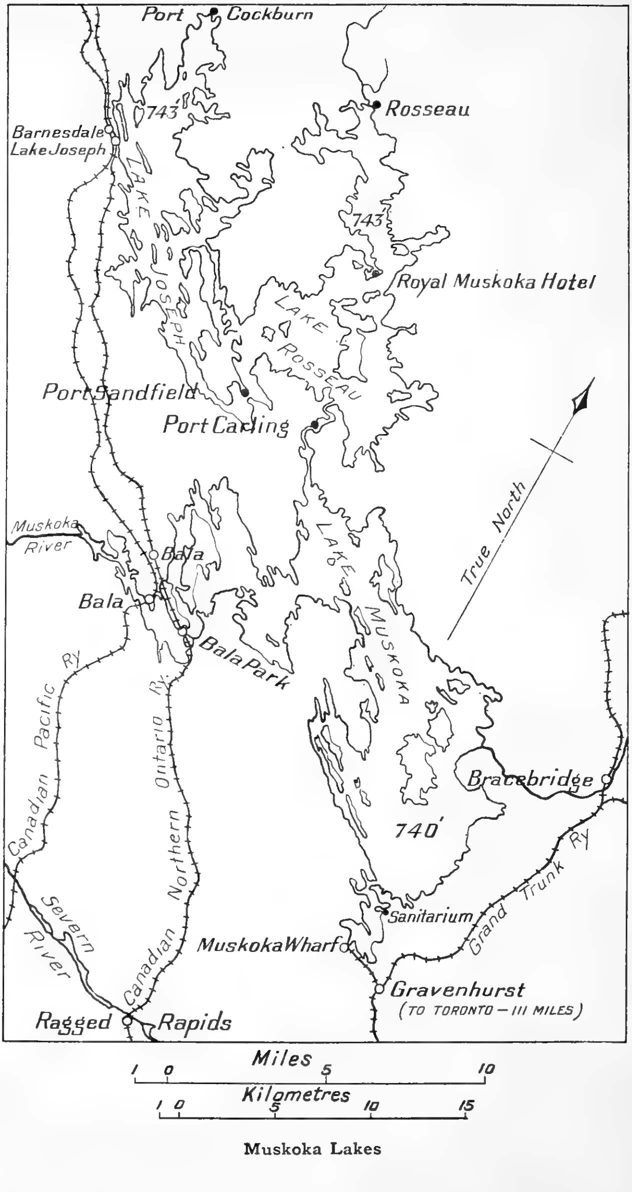
G. G. S. Lindsey, *Leader.*

The Muskoka lakes region is known as the " Highlands of Ontario." It contains numerous clear-water lakes and many popular summer resorts.

THE LAURENTIAN.

The rock cuttings along the branch railway between Gravenhurst and Muskoka wharf afford excellent sections of the Laurentian, bringing out clearly the method by which the characteristic banded gneiss has been produced. Here and there masses of dark green-grey rock may be seen, sometimes of considerable area. These patches of diorite schist or of biotite schist are, no doubt, metamorphosed basic rocks, such as gabbro, older than the granite which penetrates them as dikes and floats off fragments from their margins. At first the fragments are angular and sharp edged, but at a greater distance from the parent mass they become rolled out as schistose streaks, and along with this goes *lit par lit* injection of granite magma, sometimes as thin, light-colored sheets, at others as distinct granite dikes. The result is a strikingly banded gneiss, grey if the original basic material was in larger amount, and flesh-colored with thin, greenish bands where the granite predominated.

Still later dikes of granite and also of coarse pegmatite have penetrated in all directions the gneisses just referred to, and one may observe the beginnings of a second operation like the first, blocks being broken off, rolled out and injected with granite parallel to the schistosity. Evidently the Laurentian gneisses represent a long continued series of granite intrusions, diluting and attenuating more and more the basic materials which once made the crust through which the eruptions took place.



Muskoka Lakes

In some places the strike and dip of the schistosity may be traced from point to point in such a way as to encircle areas of granite, showing a ground plan of batholithic mountain structures, domes which have lost thousands of feet by later erosion, so that the relief is now comparatively low.

The Muskoka lakes, with their remnants of original greenstones and their much larger area of grey or flesh-colored granitoid gneiss arranged ovally about less schistose centres of granite, afford typical examples of the Laurentian rocks, which cover more than half of northern Canada. They also show admirable examples of the lake basins which occupy nearly a quarter of the original peneplane of the Canadian Shield. After peneplanation had been accomplished the region was elevated some hundreds of feet and rivers eroded valleys, though not to great depths. Then came the ice sheets of the glacial period, scouring off the debris, leaving clean, rounded and striated rock surfaces, and blocking all the valleys with boulder clay or moraine ridges. When the ice departed all the hollows formed lakes, each of which spills over at the lowest point into the next lake below as falls or rapids. The connecting rivers have not yet had time to cut channels in the rock, and their erratic courses add much to the beauty of the wilderness of lakes spread over the Muskoka region. It is typical "rocky lake" country, with lakes and ponds and inlets and islands of all shapes and sizes, making a veritable labyrinth of waters, which reflect rock cliffs and groves and give sheltered navigation for launches and canoes.

ANNOTATED GUIDE.

Toronto to Gravenhurst.

Miles and Kilometres.	
0.0 2.2 m. 3.5 km.	**Toronto,** Union station, altitude 254 feet (77.4 m.). North Parkdale, altitude 391 feet (119.2 m.). Leaving Toronto by the Northern division of the Grand Trunk railway, the train passes over a drift-covered area which is underlain by Paleozoic rocks.

Miles and Kilometres.

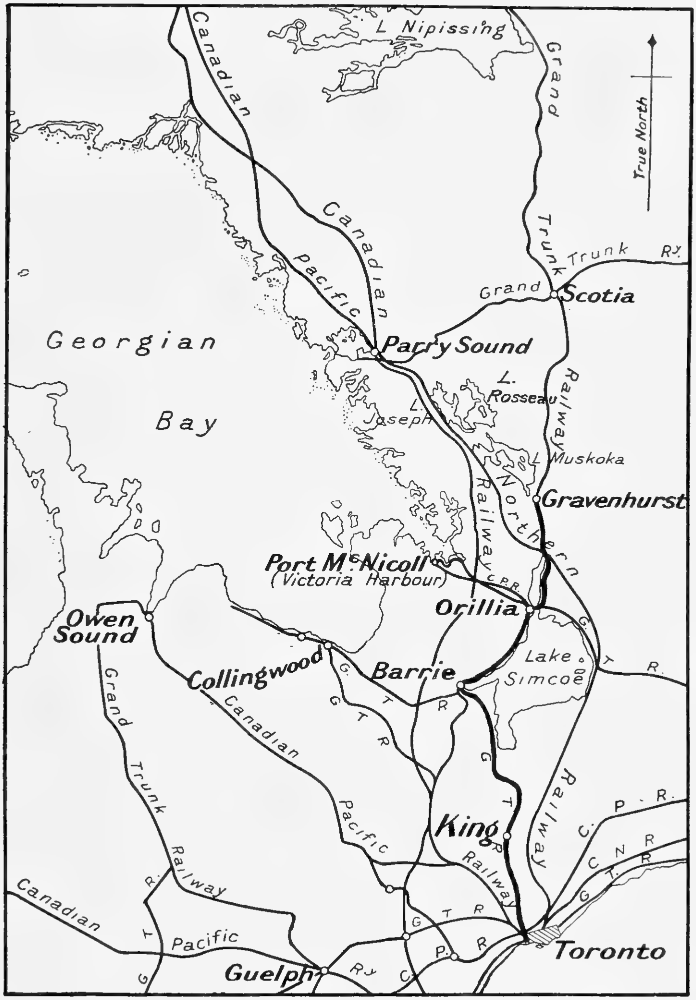
4.6 m. 7.4 km. **At Davenport** there are gravel bars of glacial lake Iroquois, while two miles to the east the old shore line of this lake is exposed.

22.4 m. 36.1 km. **At King** an altitude of nearly 1,000 feet is attained. The country traversed consists of rolling ridges of Pleistocene deposits, made up of stratified clays, sands and gravels, and material of glacial origin. To the north of King much of the country is strewn with boulders.

48.7 m. 78.6 km. The first view of lake Simcoe is obtained from a point just south of GILFORD STATION.

62.7 m. 101.1 km. **At Allendale** a splendid view is obtained of the town of Barrie on Kempenfeldt bay. To
64.0 m. 103.2 km. the south of BARRIE, as far as the township line, the drift has an average depth of 300 feet or more. "Throughout this area of deep drift a considerable part is made up of water laid or lake sediments as distinguished from glacial or ice-laid deposits. Locally, as in the case of the high mass west of Barrie, a large part is water laid—chiefly stratified sands and clays. But ice laid drift is generally dominant" (Taylor).

86.0 m. 138.7 km. **North of Orillia** there is a cutting through boulder clay. All the country from Toronto north, as far as Longford, is underlain by flat-lying sediments of Paleozoic age, including, from the south, Lorraine, Utica, Trenton, Black River and Bird's Eye formations. The first outcropping of rock along the railroad occurs at
93.5 m. 150.8 km. LONGFORD, where Black River limestone is seen. At the Longford quarries, on the west side of St. John lake, Rama township, four feet of Black River limestone are exposed at the top, in two heavy layers containing an abundance of characteristic fossils, such as *Columnaria Halli, Stromatocerium rugosum,* etc., and a six-foot bed at the bottom is a mass of *Tetradium fibratum.* Below this are twelve feet of fine-grained blue and dove-colored limestone containing *Leperditia,* but comparatively few other fossils. This lower bed has been referred to the Bird's Eye formation (Johnson).



Route map between **Toronto** and **Muskoka**

Miles and
Kilometres.

95 m.
153.3 km.

The limestone forms a low escarpment facing northwards, and after a short drift-covered stretch coarse red granitoid gneiss shows itself beyond as a plain with low relief.

98.5 m.
158.8 km.

At Washago, the red gneiss, which is exposed in a quarry near the railroad, contains long bands or thin sheets of grey-green biotite schist, sometimes crumpled and slightly faulted. From this point to Gravenhurst the greyish or flesh-colored Laurentian gneiss rises as hills of moderate height, and the shores and islands of the Muskoka lakes the mainly formed of similar rocks.

111.4 m.
179.7 km.

At Gravenhurst, altitude 818 feet (249.3 m.), a branch railway extends for a mile and a half to Muskoka wharf, altitude 749 feet (228.3 m.), where steamers are in waiting for visitors. The rock cuttings along this branch afford excellent sections of the Laurentian, bringing out clearly the method by which the characteristic banded gneiss has been produced.

EXCURSION B 8

CLAY DEPOSITS AND WORKS NEAR TORONTO.

BY

M. B. Baker.

CONTENTS.

INTRODUCTION.

There are no high-class ceramic industries in Canada using Canadian clays, because there are no kaolin deposits of worth in Canada. Pleistocene glaciation removed all products of rock decay, and therefore all deposits of residual clay, and left only a mixed glacial drift. In some places this has been more or less sorted, so that a clay-like material containing a large percentage of rock flour is found, and this is used for the manufacture of ordinary building-brick, field tile, or common pottery. These impure clays in the fresh and unaltered state are high in calcium carbonate, varying from 13 per cent. to 27 per cent. The iron oxides run about 7 per cent. In burning these clays the iron is prevented from burning to the ferric oxide, but forms instead ferrous carbonates and silicates, which give the buff to cream colors found in these products. There is an unlimited supply of this clay in Canada, but it is of a poor grade and yields only the commonest products.

In flat areas, or in more or less hollow places, where weathering has taken place, and where the products have had little chance to be removed, we find that the meteroic waters have leached out the calcium carbonate from the upper two to eight feet of our glacial clays. This has reduced the calcium carbonate to as low as 6 per cent. in most cases, but since iron oxide is insoluble it remains the same as in the glacial clay. On burning this weathered clay, the iron oxide is now able to change to the ferric condition, and yields as a result the red products with which all are familiar.

Since this red-burning clay is confined to the weathered top of the glacial clay and to interglacial clay, we can see that the supply is limited. Beyond the change in color, the other qualities of the burnt product are not improved.

All higher grade products, including pressed-brick, terracotta sewer-pipe, paving-brick, etc., are made in Canada from shales of the Paleozoic series. Three of these are used so far in Canada, namely, the Utica, Lorraine and Medina. The first of these is used in the vicinity of Montreal, but has not yet been used in Ontario. The latter two are used in the vicinity of Toronto.

DON VALLEY BRICK WORKS.

The most interesting clay and shale deposits at Toronto belong to the Don Valley Brick Works, where the following section is seen in descending order:

1-3 feet boulder drift clay.
80 feet glacial stratified clay ....A.
1 foot boulder drift clay.
21 feet interglacial cool water beds. }
12 feet interglacial warm water beds } ....B.
of clay and sand.
12 feet reddish sand, often carbonacious..............C.
3 feet boulder drift.
60 feet Hudson River shales, with interbanded limestone ....D.

It is not the writer's intention to describe these clays geologically, as this has been already done by Dr. Coleman in the guide-book to excursion B 2, but the object of this excursion is to study the industrial side of these clays.

The upper glacial clay A has been collected rapidly, and is of the character already described in the introduction above. It has not lost its calcium carbonate, and therefore burns to buff-colored products. This clay is dug by itself and manufactured into sand-stock brick, and hollow-spaced block.

The interglacial banded clays B were slowly-collected weathered clays, which had lost their calcium carbonate before or during the gathering process, they therefore burn, as was described in the introduction, into red ferric products. These two banks, thirty-three feet in all, are therefore dug with a steam shovel and manufactured by themselves into red sand-stock brick and red wire-cut brick. The underlying twelve feet of reddish sand is dug and mixed at times with these interglacial clays B when they, of themselves, are too "fat" or strong for the purpose in hand. The addition of this sand diminishes the shrinkage and cracking on drying or burning.

At the base of these clays there is a three-foot layer of boulder clay, which has to be removed and discarded, when the underlying Lorraine shale comes to view. This shale is blasted out, picked free from limestone beds,

and is then finely pulverized, when it is ready for use by itself in the manufacture of dry pressed brick, which burn to a beautiful red color. It is often mixed with other clays, for example the calcareous clay A to form various shades of buff to cream colored products.

It is not advisable to go into any detailed description of the process of brick-making, which is best seen at the brick yard, but it may be briefly summarized as follows:—The various sand-stock bricks, which get their name from being made in sanded moulds; the wire-cut brick, which are cut off in the required sizes from a continuous column of clay by passing a wire; and the hollow block, made in the same way as the wire-cut brick, with variations in the die; are all taken directly to tunnel dryers on steel cars, on which they remain during the drying process. They emerge from the opposite end of the tunnel, and are taken to down-draft kilns. The dry-pressed bricks go directly from the presses to the kiln, as they require no drying. These kilns are single, or double, or continuous, and all burn by soft coal, except the largest and latest one, which is an enormous continuous kiln, burned by producer gas. After seven to ten days burning the kilns are cooled and the products are ready for market.

SWANSEA SEWER PIPE WORKS.

The plant of the Dominion Sewer Pipe Co. is at Swansea, to the west of Toronto. This company uses Medina shale dug near Waterdown, thirty-five miles west of the city, the shale being brought in cars to the plant at Swansea. Only the upper weathered portion of these beds, from which the lime and magnesia have been largely leached, is used in the manufacture of sewer-pipe. The shale is ground as at the Don Valley brick works, and is then mixed to a stiff plastic putty with water. It is now forced by a plunger machine through dies of the required size, turning out thereby the hollow sewer-pipe, which are cut off by wires, as in the case of the wire-cut brick. The pipes are then slowly dried in large rooms with perforated floors, heated very slowly but continuously with ordinary steam radiators.

After thorough drying the tiles are removed to large beehive down-draft kilns, where they are stood on end, the smaller ones being nested inside the larger to conserve space

and maintain even drafts. After the ware has been burned to the consistency of red brick, they must undergo the further process of glazing. For this purpose common salt is thrown into the fire-boxes with the fuel, and the temperature raised to such a point that the surfaces of the tile are just fusing. This heat is maintained for a short time, the salt fumes are carried through the kiln, and on meeting the clay, which is just at the fusion point, form a sodium iron silicate with the clay, forming a glaze, covering the tile very perfectly. It is easily seen that this must not be carried too far, or the ware would fuse down and become distorted and quite misshapen. After the glazing the kiln must be cooled very gradually, a process usually distributed over three days, and even then the tile are as hot as the men can handle with buckskin gloves.

Hastings (pre-Cambrian) conglomerate, Southeastern Ontario

EXCURSION B 10

THE MADOC AREA.

BY

CYRIL W. KNIGHT.

CONTENTS.

INTRODUCTION.

Madoc, a town of about 1,100 people, in the township of the same name, Hastings county, is situated 123 miles east of Toronto and eight miles north of the main line of the Canadian Pacific railway between Montreal and Toronto. A branch line of the Grand Trunk railway from Belleville runs into the town, which lies a few miles to the north of the Paleozoic escarpment and on the southern fringe of the great pre-Cambrian shield.

The town was the site of early attempts to smelt and mine iron ores, and a small furnace, built in 1837, was operated for eight or nine years, using charcoal. The ore was obtained from the Seymour mine, situated about three miles north of the town. Later, in the year 1866, intense excitement was created by the discovery of a small pocket of gold ore at a point about eight miles north of Madoc. There was scarcely a lot in the immediate vicinity on which pits or shafts were not sunk. Since that time iron ore, copper pyrites, gold and other minerals have been spasmodically mined in a small way in the vicinity. At the present time, however, the Henderson talc mine, on the outskirts of the town, and the Canadian Sulphur Ore Company's pyrite mine, which lies several miles to the northeast of Madoc, are being successfully operated.

GENERAL GEOLOGY.

Briefly, the geology may be summarized as follows: The rocks fall naturally into two great groups: (1) Paleozoic, and (2) pre-Cambrian. The Paleozoic consists of horizontal beds of limestone of Ordovician age (Black River). These beds rest with great unconformity on the pre-Cambrian. The latter consists, beginning with the most ancient, of the Keewatin series, which is made up of greenstone schists, which sometimes retain ellipsoidal structures and amygdaloidal textures. The Keewatin is not exposed at Madoc, but occurs in considerable volume in adjacent areas.

On the Keewatin lavas were laid down a very thick series of sediments, now highly metamorphosed, known as the Grenville, and composed of schistose quartzite, greywacké, iron-formation (jaspilyte), slate and crystalline limestone. Both the Keewatin and Grenville were invaded by the Laurentian gneissoid granite.

Beds of Slate, 1 and 3, Interbedded with Crystalline Limestone "Conglomerate," Pre-Cambrian, Madoc

After the intrusion of the Laurentian there was a prolonged period of erosion, and the Hastings sedimentary series, consisting of conglomerate and other rocks, was laid down.

Finally all the older rocks were invaded by the Moira granite and felsite, and later by basic dikes.

On the surface of the pre-Cambrian rests the Black River limestone, the lower formations of the Ordovician being absent in the district.

The accompanying colored map, scale 1,000 feet to the inch, shows the distribution of the rocks in the Madoc area.

ECONOMIC MINERALS.

TALC. A large body of talc is located on the southern outskirts of the town of Madoc. The deposit occurs in a brown, somewhat quartzose crystalline limestone of Grenville age, an analysis of which shows it to have the following composition: Ca O, 29.29 per cent.; Mg O, 15.53 per cent.; CO_2, 43.67 per cent.; insoluble, 4.62 per cent. The talc has a width which varies from 25 feet or less to 40 feet. The crystalline limestone on each side of the deposit contains bands of white quartz several feet or more wide. A horizontal plan shows the talc to occur in the form of a horseshoe, or the letter "V," due to the strata having been sharply folded. The material has been mined a distance of about 500 feet, but the extent of the body has not yet been determined in the underground workings; and the surface on each side of the hill is covered with drift.

It is probable that the talc has resulted from the alteration of the crystalline limestone, since many parts of the occurrence still show distinct traces of the original bedding or lamination of the limestone. The origin of the talc may be partly connected with the intrusion of the Moira granite from which circulated silica holding waters. The latter probably acted on the dolomitic limestone, giving rise to the hydrated, magnesian silicate, talc.

PYRITE. The pyrite mine of the Canadian Sulphur Ore Company is situated several miles northeast of Madoc near the village of Queensboro. The ore body occurs in Grenville rocks at the contact of a bed of fine-grained, rusty schist and quartzite, both beds resting in almost vertical position.

Henderson Talc Mine, Madoc.

An intrusion of grey felsite, which lies about 100 yards southeasterly from the deposit, is believed to be genetically connected with the ore body. The rusty color of the schist is due to the decomposition of pyrite and pyrrhotite, with which the schist is highly impregnated. Hot solutions accompanying the felsite magma may have effected a concentration of the sulphides originally contained in the schist, resulting in the formation of the ore body. The rusty schist occurs not uncommonly in various parts of southeastern Ontario. The sulphides accompanying it may have been deposited at the time the rock was originally laid down as a shale.

FLUORSPAR. Several veins of fluorspar, varying in width from a few inches to six or seven feet, occur within a radius of two or three miles of Madoc. They are all probably post-Ordovician in age, since one of them intersects limestone beds of the Black River formation. The others occur in felsite, crystalline limestone and other rocks of pre-Cambrian age. Associated with the fluorspar are subordinate amounts of barite.

BIBLIOGRAPHY.

The geology of the Madoc and surrounding areas is described in Part II of the 22nd Annual Report of the Ontario Bureau of Mines, in which references to earlier literature are given. Seven geological maps accompany the report.

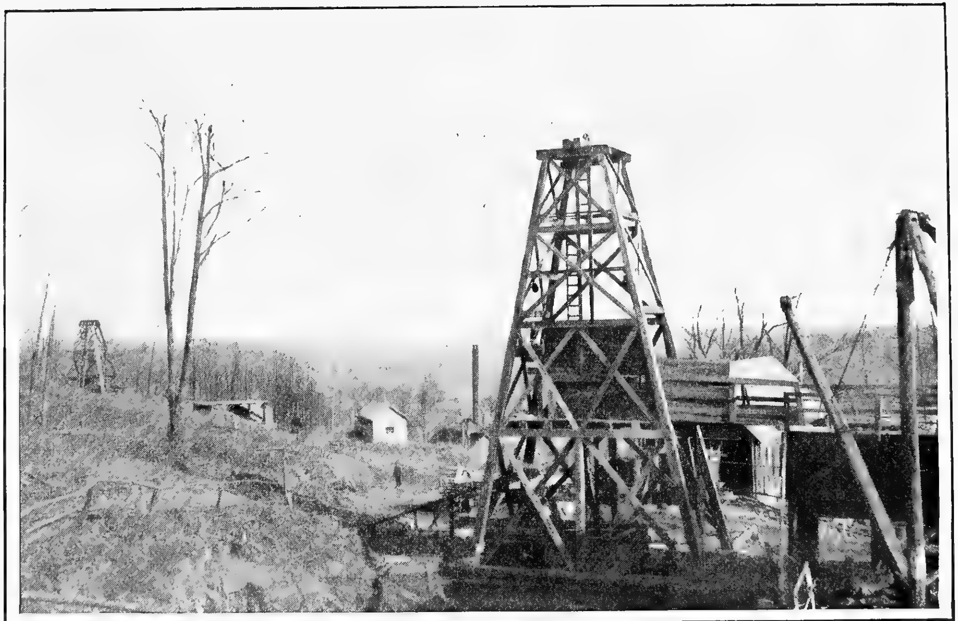
ANNOTATED GUIDE.

TORONTO TO IVANHOE.

Miles and
Kilometres.

0.0 — Toronto, altitude at water-line of lake Ontario is 246 feet (74.9 m.).

100.8 m.
162.2 km. — The country between Toronto and Havelock is heavily covered with Glacial and Recent deposits of boulder clay, sand, gravel, etc., and outcrops of Paleozoic rocks are almost lacking. At Toronto the boulder clay is seen to be resting on Lorraine shales. Thus in the Humber and Don valleys contacts of the shales and Glacial deposits may be seen.



Canadian Sulphur Ore Company's Property, Looking East.

Miles and Kilometres.

103. m. A few miles east of Havelock Black River
165.7 km. limestones are exposed, and the pre-Cambrian complex also makes its first appearance about one-quarter of a mile north of the railway track, where trap is developed on the surrounding hills, and is being quarried and crushed for road metal.

122.8 m. Between Havelock and Ivanhoe flat-lying
197.6 km. limestone is exposed, except where covered by extensive swamps which occur in this area. These Paleozoic limestones continue to within
132. m. a few miles of Tweed, and the surface of
212.4 km. the country presents a striking appearance owing to the numberless boulders of the limestone which cover it. At Tweed pink granite gneiss and Trenton limestone are exposed.

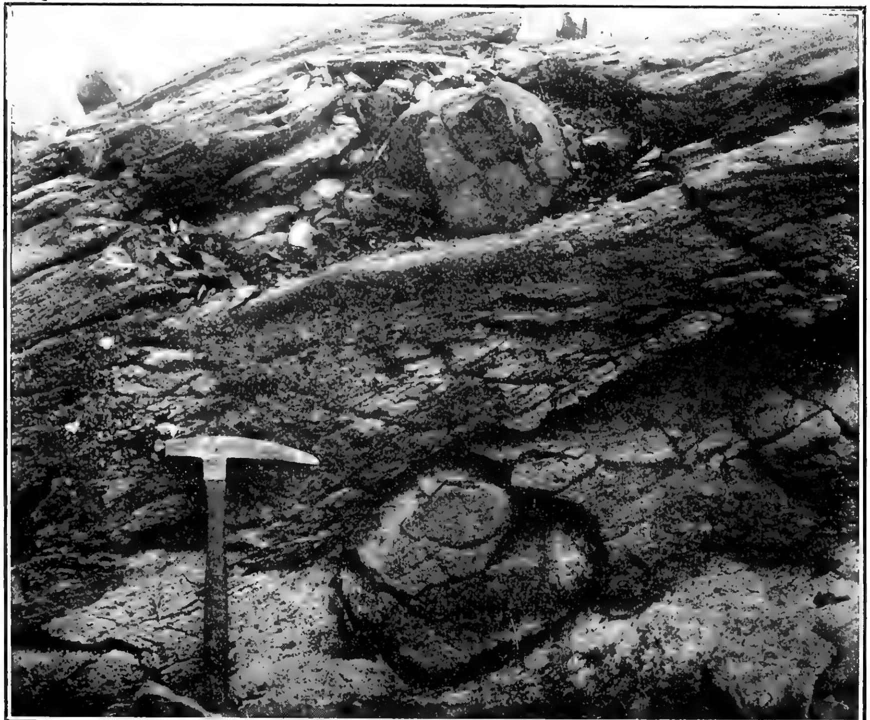
Ivanhoe to Madoc.

The village of Madoc, which lies about seven miles north of the Canadian Pacific railway, is connected by wagon road with Ivanhoe station, and for four miles north of the station the road passes over horizontal beds of Ordovician (Black River) limestone. The northern face of this limestone presents a steep escarpment, the latter presumably caused by a fault. To the north of the escarpment the great expanse of the pre-Cambrian shield is entered, and the village of Madoc is seen resting on the southern fringe of these ancient rocks. The topography of the country underlain by the Black River limestone is flat or gently rolling, while that presented by the complex peneplain of the pre-Cambrian is comparatively rugged.

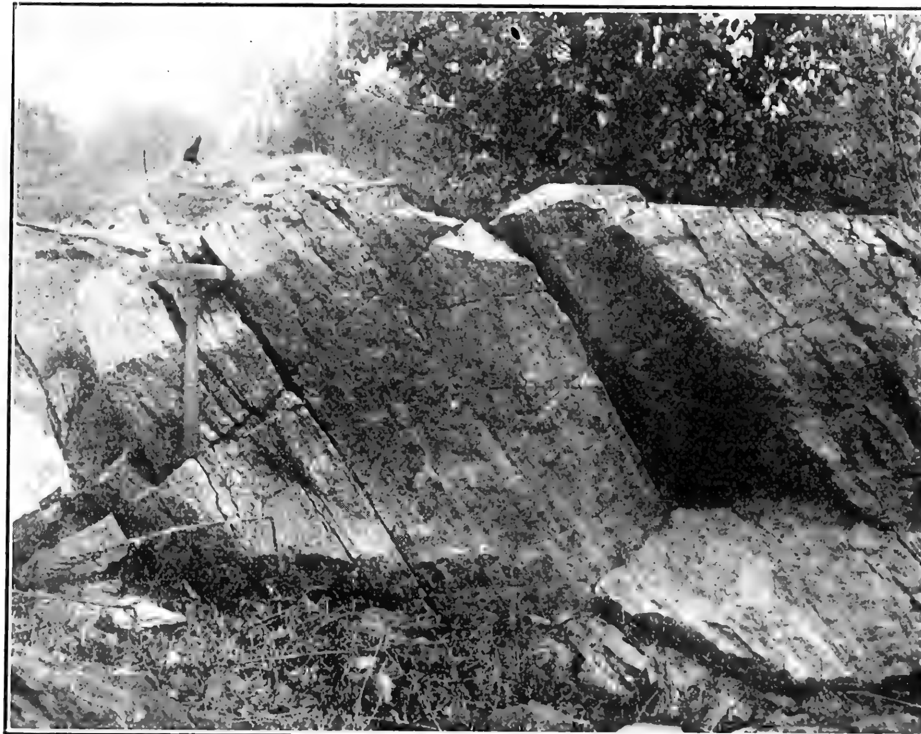
Crystalline limestone, Grenville series, Southeastern Ontario.

Eozoon-like structures in crystalline limestone, Grenville Series.

Surface of crystalline limestone, Grenville Series



Volcanic bombs in ash beds, pre-Cambrian, Southeastern Ontario



Iron formation (jaspilyte) in the Keewatin of Southeastern Ontario

LIST OF ILLUSTRATIONS

MAPS.

DRAWINGS AND SECTIONS.

PHOTOGRAPHS.

Pocket contains
3 items

TORONTO

To accompany Part 1, Volume

. Hearst, *Minister*

Scale: $\frac{1}{63,3}$

¼ ½ ¼ 0 1

1000 500 0 1 2

79°20

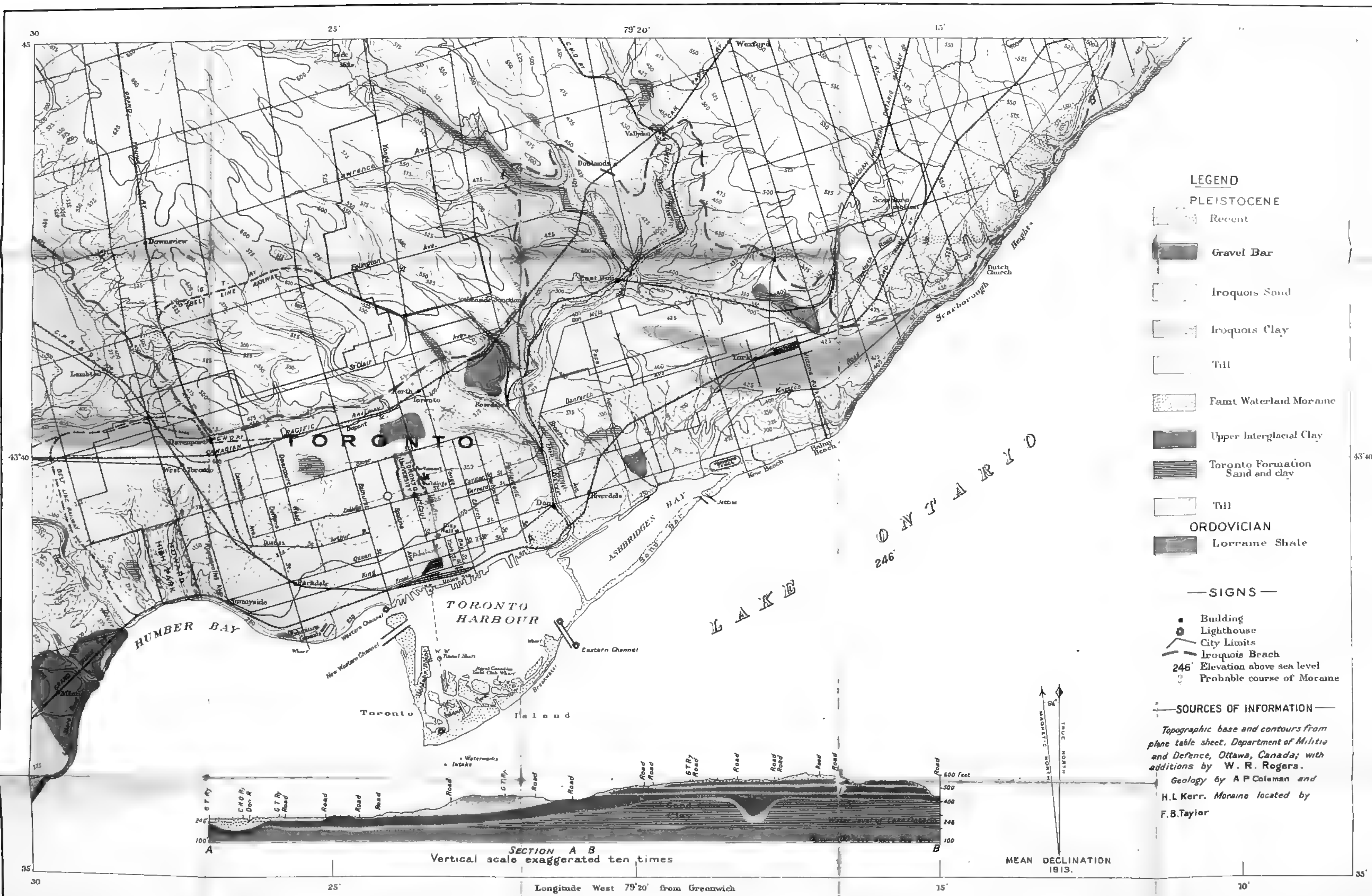
ONTARIO
DEPARTMENT OF LANDS FORESTS & MINES
BUREAU OF MINES

MAP OF TORONTO AND VICINITY

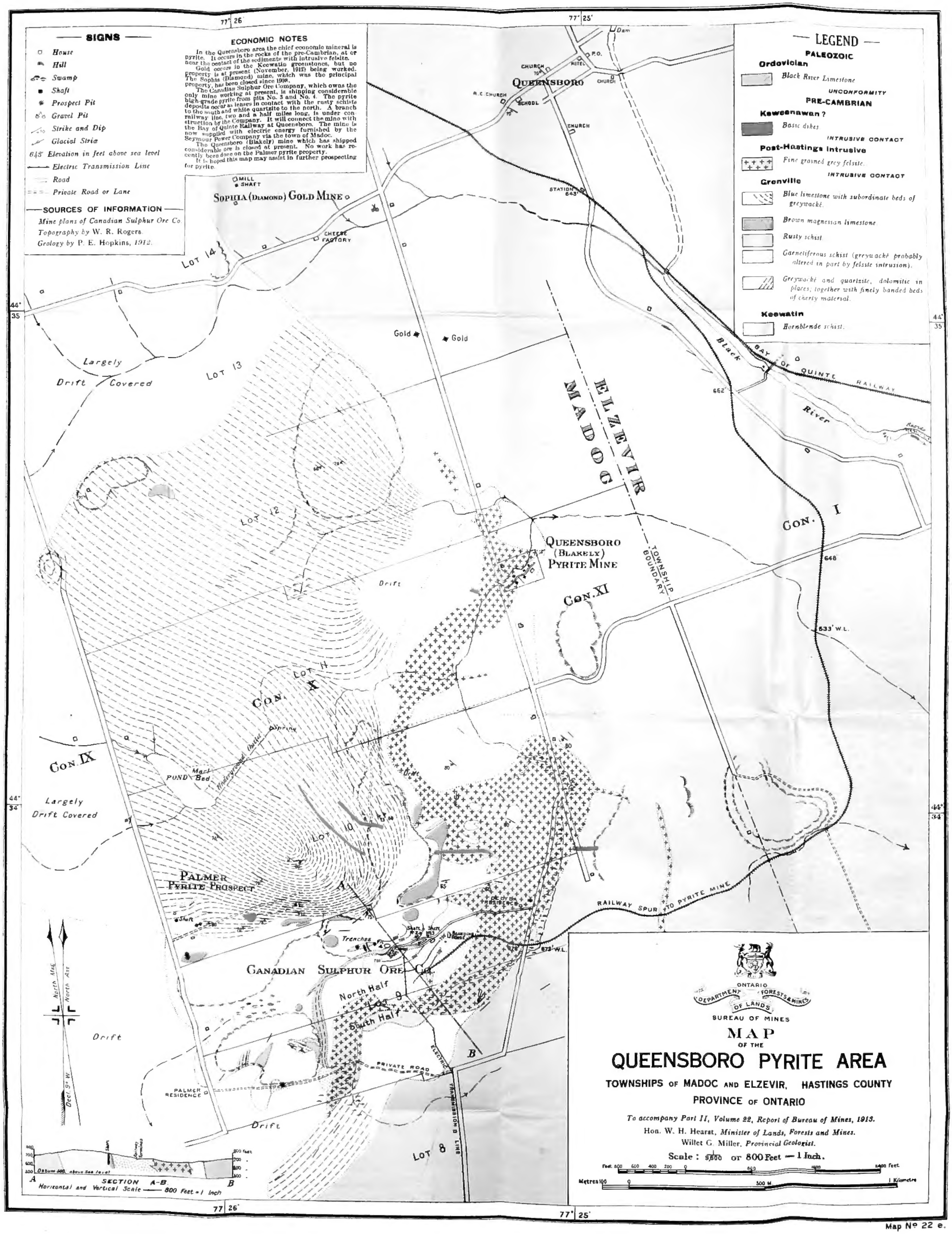
To accompany Part 1. Volume 22 Report of Bureau of Mines, 1913

Hon. W. H. Hearst, *Minister*   Willet G. Miller, *Provincial Geologist*

Scale: $\frac{1}{63,360}$ or 1 Mile = 1 Inch



Map Nº 22 g


77° 26'
77° 25'
SIGNS
House
Hill
Swamp
Shaft
Prospect Pit
Gravel Pit
Strike and Dip
Glacial Striæ
648 Elevation in feet above sea level
Electric Transmission Line
Road
Private Road or Lane
SOURCES OF INFORMATION
Mine plans of Canadian Sulphur Ore Co.
Topography by W. R. Rogers.
Geology by P. E. Hopkins, 1912.
ECONOMIC NOTES
In the Queensboro area the chief economic mineral is pyrite. It occurs in the rocks of the pre-Cambrian, at or near the contact of the sediments with intrusive felsite.
Gold occurs in the Keewatin greenstones, but no property is at present (November, 1912) being worked. The Sophia (Diamond) mine, which was the principal property, has been closed since 1908.
The Canadian Sulphur Ore Company, which owns the only mine working at present, is shipping considerable high-grade pyrite from pits No. 3 and No. 4. The pyrite deposits occur as lenses in contact with the rusty schists to the south and white quartzite to the north. A branch railway line, two and a half miles long, is under construction by the Company. It will connect the mine with the Bay of Quinte Railway at Queensboro. The mine is now supplied with electric energy furnished by the Seymour Power Company via the town of Madoc.
The Queensboro (Blakely) mine which has shipped considerable ore is closed at present. No work has recently been done on the Palmer pyrite property.
It is hoped this map may assist in further prospecting for pyrite.
LEGEND
PALEOZOIC
Ordovician
Black River Limestone
UNCONFORMITY
PRE-CAMBRIAN
Keweenawan ?
Basic dikes
INTRUSIVE CONTACT
Post-Hastings Intrusive
Fine grained grey felsite.
INTRUSIVE CONTACT
Grenville
Blue limestone with subordinate beds of greywacké.
Brown magnesian limestone
Rusty schist
Garnetiferous schist (greywacké probably altered in part by felsite intrusion).
Greywacké and quartzite, dolomitic in places; together with finely banded beds of cherty material.
Keewatin
Hornblende schist.
QUEENSBORO
Dam
P.O.
HOTEL
CHURCH
R.C. CHURCH
SCHOOL
STATION
MILL
SHAFT
SOPHIA (DIAMOND) GOLD MINE
CHEESE FACTORY
LOT 14
LOT 13
LOT 12
LOT 11
LOT 10
LOT 9
LOT 8
44° 35
44° 34
Gold
Largely Drift Covered
ELZEVIR
MADOC
TOWNSHIP BOUNDARY
BAY OF QUINTE RAILWAY
Black River
662'
648
633' W.L.
CON. I
CON. XI
CON. X
CON. IX
QUEENSBORO (BLAKELY) PYRITE MINE
Drift
Spring
Underground Outlet
POND
Marl Bed
PALMER PYRITE PROSPECT
Shaft
Trenches
CANADIAN SULPHUR ORE CO.
North Half
South Half
RAILWAY SPUR TO PYRITE MINE
PRIVATE ROAD
ELECTRIC TRANSMISSION LINE
PALMER RESIDENCE
A
B
North Mag.
North Ast.
Decl. 9° W.
SECTION A-B
Horizontal and Vertical Scale — 800 Feet = 1 Inch
Datum 500 above Sea level
ONTARIO
DEPARTMENT OF LANDS FORESTS & MINES
BUREAU OF MINES
MAP OF THE
QUEENSBORO PYRITE AREA
TOWNSHIPS OF MADOC AND ELZEVIR, HASTINGS COUNTY
PROVINCE OF ONTARIO
To accompany Part II, Volume 22, Report of Bureau of Mines, 1913.
Hon. W. H. Hearst, Minister of Lands, Forests and Mines.
Willet G. Miller, Provincial Geologist.
Scale: 1/9600 or 800 Feet = 1 Inch.
Feet
Metres
1 Kilometre

Map No 22 e.

ONTARIO
DEPARTMENT OF LANDS FORESTS & MINES
BUREAU OF MINES

MAP
OF THE

MADOC AREA

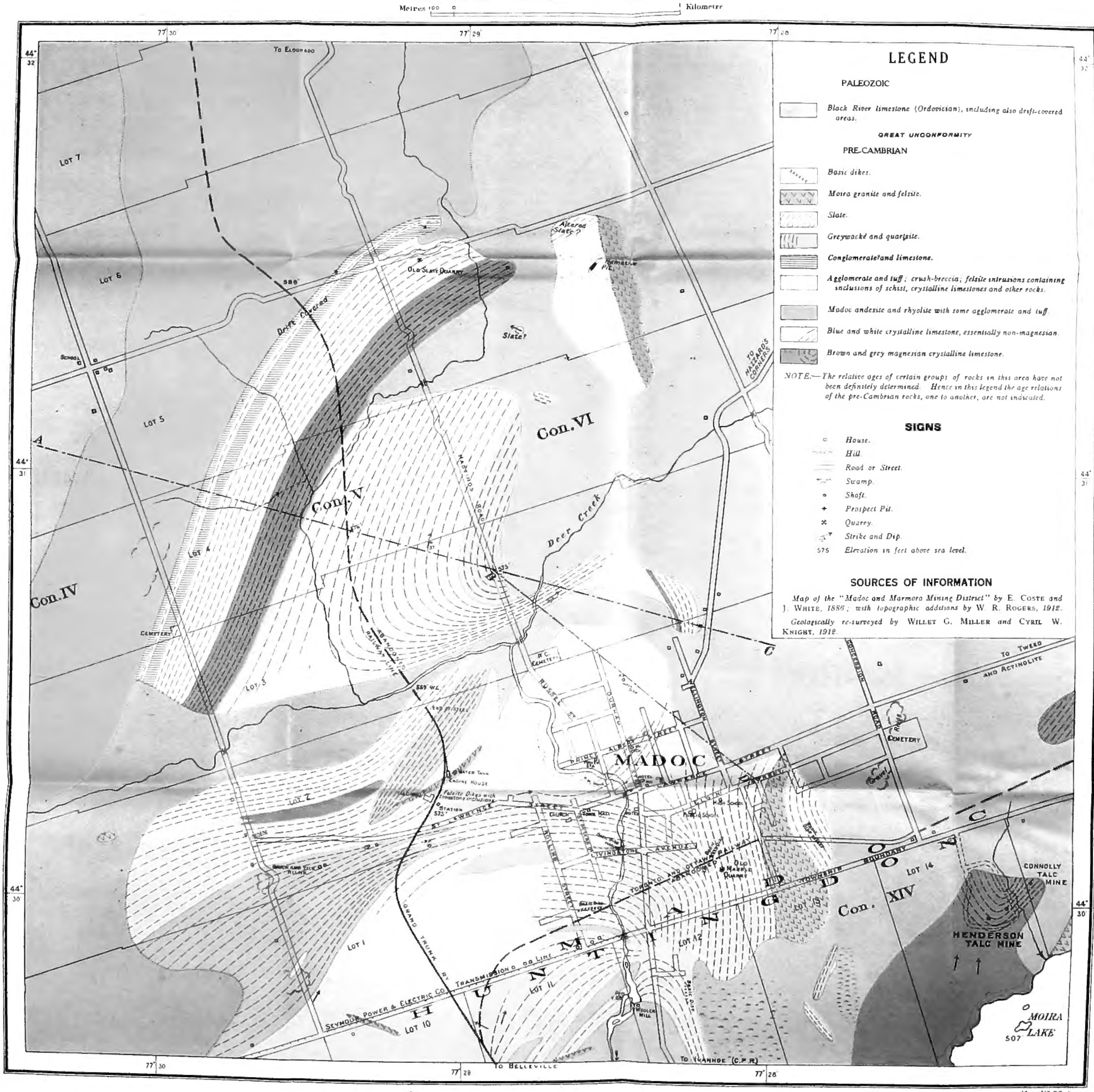
TOWNSHIPS of MADOC and HUNTINGDON, HASTINGS COUNTY

PROVINCE of ONTARIO

To accompany Part II, Volume 22, Report of Bureau of Mines, 1913

Hon. W. H. Hearst, *Minister* Willet G. Miller, *Provincial Geologist*

Scale $\frac{1}{12000}$ **or 1,000 Feet = 1 Inch**



Map Nº 22 d